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the Inventor of it. His Words are these,—“ Supra
 “ hoc Microscopium Catillum ferruminavi, ut oculus
 “ objecta tanto melius videret: nam cuprum circa
 “ Microscopium, quantum pote, lima abraferam, ut
 “ Lumen in conspicienda objecta, quantum pote,
 “ irradiaret.”

See the Figure of this Apparatus in TAB. IV. at G.

X. *An Inquiry into the Causes of a dry and wet Summer. By an anonymous Hand.*

THE wet Weather which we had in *March* 1734. (the Year beginning with *January*) set me on considering what might be the Causes of it. The Wind was then, generally, South-west, the Weather rainy. Sometimes it veered to South-east, which, commonly, brought much Rain: But the Wind seldom stood at that Point 24 Hours, before it returned to South-west again. A strong Gale at South-west, with Rain, would be succeeded by as strong at North-west, still raining; but if the North-west continued 24 Hours, it cleared the Sky. The Summer following was cold and wet; the Wind on the same Points. The preceding Winter was mild, and especially *December*, in which Month, from the 10th inclusive, the Wind blew, generally, South-west, sometimes strong, attended with much Rain. At the End of *December*, the Birds sang, and the Grass did grow as at other Years in the Spring.

The Winter of 1734. was as mild as that of 1733. the Birds as joyful, and the Grass as green at the End
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of *December*, the same Winds still prevailing; but the South-west was more stormy. On *December* 29th, there blew a Storm, first from South-west, and then from North-west: But the Storm of *January* the 8th was much stronger, which blew on the same Points. The Summer of 1735. was colder, and wetter than the preceding Summer.

This put me on recollecting what sort of Winter went before a dry Summer. In the Year 1731. the Summer was remarkably dry. I had not begun to keep a Journal of the Weather in the Year 1730. But I took so much Notice of the unusual Cold in *April* 1731. that I made the following Remarks. *April* 1. begins with piercing cold Winds at North-east, black Clouds, stormy, very dry. 4th, 5th, some Wind, Ice. 6th, 7th, 8th, 9th, same Wind. 9th, Snow. 10th, The Harbour frozen over. If my Memory doth not fail me very much, it was in the Winter of the Year 1730. or the Beginning of 1731. that a *Horse* was frozen to Death in *Moscow*, as he stood in the Street.

From hence I conclude, that a frosty Winter produces a dry Summer; and a mild Winter a wet Summer. I am sensible, that these Conclusions are drawn from short and imperfect Observations: But, supposing them to be true, I would be glad to know why these things are so.

I find from these and some other Observations, which I have casually made, that the Weather depends very much on the Wind. I shall therefore begin with inquiring what is the Cause of Winds, and then proceed to find out, as well as I can, why the Wind doth influence the Weather.

Wind

Wind is a Stream of Air; Air an unmixed Fluid encompassing our Globe, with a Shell of at least 60 Miles thick. Every Particle of Air gravitates equally towards the Centre of the Earth. Air is capable of being compressed and expanded: The more Air is compressed, the heavier it is; the more it is expanded, the lighter. Cold and Heat, whatever they be, or however they act, produce these contrary Effects in the Air: That is, Cold doth compress the Air, and Heat expands it: Therefore Cold and Heat, in different Parts of the Air, will make it flow: For Cold making the Air heavy, and Heat making it light, the lighter must, of course, give Way to the heavier; as, in a Balance, a greater Weight makes a smaller rise. We daily see a Proof of this in a Stove.

The Sea and Land-breezes, and the Trade-wind, owe their Original to the same Causes. The Sea-breeze, when regular, begins at Nine o'Clock in the Morning, approaches the Shore gently, at first; increases till Twelve; retains its full Strength till Three; then gradually decreases till Five, when it dies away. At Six in the Evening the Land-breeze begins, and continues till Eight next Morning: The Interval between these Two Breezes, at Morning and Evening, are the hottest Parts of the Day. It is said, that these Winds vary in their Periods; which not being to my Purpose, I take no Notice of.

The way of accounting for this Vicissitude of Sea and Land-wind, is thus: The Sun, as it ascends, sheds its Heat equally on the Land and Sea; but the Earth receives the Heat sooner than the Water, or else reflects it stronger. For one or both of these Reasons, the Air that hangs over the Land, is heated more

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than the Sea-air, it becomes thereby more rarefied, and consequently lighter; and therefore the Sea-air, with its superior Weight, flows in upon it every Way. The Intervals between are owing to the Air of both Places being in an equal Degree of Heat, and consequently of equal Weight.

The Trade-wind never varies, which is thus accounted for: The Air just under the Sun is the hottest: The cold Air presseth upon the hot, as the hot Air follows the Sun; and therefore it makes a perpetual Flow of Wind between the Tropics from *Africa* to *America*, and from thence to the *East-Indies*.

With regard to the Wind influencing the Weather; I find that though Air be an unmixed Fluid, yet it is capable of receiving many Vapours, which float in it, as we see other Bodies float in Water. Sometimes the Vapour ascends, and sometimes it falls to the Ground. All which I take to be effected by Heat and Cold in this Manner: Heat separates Water into small Particles, and the incorporated Air, rarefied by the same Heat, blows up those Particles into Bubbles; by which means the swoln Vapour becoming specifically lighter than a like Space of ambient Air, ascends, swift, at first, (which affords a pleasant Sight in a warm Summer's Day) and then gradually slower, till it gets up to that Part of the Air which is of equal Lightness with itself; and there it remains, as long as the Air continues in the same State: But whenever the Air cools, in which these watery Bladders float, the Cold contracts the Bladder, which becoming thereby specifically heavier than the Air, down it falls in Dew, or Rain. A common
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Alembic sufficiently shews the Operation of Heat and Cold on the ascending and descending Vapour.

Thus in a calm Evening, when there is no Wind to waft the Air, as the Heat of the Sun declines, the Cold arrests some few of the last ascending Vapours, and, by its own Force, without any other Change in the State of the Air, compels them to return, in Dew, to the very Spot from whence they arose; whilst their Brethren escape, who go out of the Reach of the Cold a little before the Approach of Night.

Since therefore the same Air, in different States of Heat and Cold, affects Vapour in this Manner, it thence follows, that Vapour, wafted from Air of one Temperament to another, must be affected in the same Manner also: So that Vapour, carried from a colder to a warmer Air, will ascend; and, on the contrary, Vapour carried from a warmer to a colder Air, will descend.

Now if Cold condenses the Air, and thereby makes it press upon the warmer; and if Vapour, carried by a Stream of Air from a colder to a warmer Region, ascends; we have the Reason why the North-east blows, and why it blows dry.

Let us fix upon some Spot in the Continent of *North-Europe*, whence this Wind comes to us: Suppose *Archangel*, which lies on our North-east Point, and is in 65 Degrees Northern Latitude: When the Frost is intense, the incumbent Air there must needs be very heavy; that Air will press every Way: *Quà data porta, ruit*. Let us consider which Way this condensed Air can burst out from thence: It cannot go to the North, where the Cold is greater;

nor to the East, for the Air over the large Continent of *Tartary* is at least of equal Coldness with itself. I make no doubt but they complain at *Archangel*, in their Turn, of cold North and North-east, and even East Winds, as much as we do here. The great Continent to their South must be so cold as to make a strong Resistance: To the West, the Air might find a free Passage over the Ocean, were not the Colds of *North-America* too near. The main Outlet is between both, towards the *Atlantic Ocean*: The warm Air over which being able, of itself, to make but a feeble Resistance, yields to the superior Force; the Conqueror eagerly pursues his Victory, and we, happening to lie directly in the Way, feel then a cold dry North-east Wind: This is the Wind that brings us Frost in the Winter. When the Winter is severe, it continues to blow all the Spring, and its Influence reaches to the End of the Summer.

This, I think, sufficiently proves, that Air, flowing from a cold to a warmer Quarter, will blow dry: But, like a willing Witness, it proves too much; for, if Wind proceeds only from cold Air pressing upon hot, and if Heat makes the Vapour ascend, it follows from thence, that Wind can never bring Rain; whereas we find the contrary by sad Experience; the South-west Wind hath ruled these Two Years, and still doth rule.

How can this be accounted for, upon the Principles commonly received? That Vapour, wafted from a warmer to a colder Region of Air, should precipitate, is what I have already shewn. But the Question is, which I have not as yet seen answered, Why does the South-west blow? What is the Cause why a Stream
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of Air should be carried, for so long a Time, and with so great Violence, as we have often felt, from a warmer to a colder, from a rarer to a denser, from a lighter to a heavier Quarter? To the North-east of us lies the Continent of *North-Europe*, great Part of which is, in the Winter, deprived of the Sun's Heat, and consequently very cold; on the other Side, to the South-west, lies the vast *Atlantic Ocean*. We find by Experience, that the Sea-shore is warmer than the Inland; that the Sea is warmer than the Shore; and that the Ocean is still warmer than the Sea. Besides, the more you go from hence towards the South, the nearer you go to the Sun; and the more North, the farther from it: This must make the South-western Ocean much warmer than the Continent, that lies at an equal Distance, on the opposite Point: From this very warm Place, the Wind blows to a Place much colder; and yet there must be a natural Cause of all this apparent Contradiction to the Laws of Nature: Whether we can find it out or not, I shall attempt it as well as I can.

It will be in vain to seek for the Cause of this Wind in this Ocean itself, or in the Air over it, influenced only by the Sun, and the Surface of the Sea. But there may be *Tornados* in those Seas: Our Seamen often meet them between the Tropics, seldom, as I am told, in the Ocean I am now speaking of, which is to the North of the Northern Tropic. But were they more frequent and violent than they really are, yet they are not lasting, and therefore cannot produce a long steady Course of South-west Winds with us.

My Conjecture is, that our South-west Wind is no other than an Eddy of the Trade-wind, reflected from *America* to us. Though we cannot see the Eddy of Air, as we do that of Water; yet we must be otherwise very sensible, that it makes a strong Recoil, when it meets with lofty Buildings, Woods, Hills, &c. The more elastic any Body is, it rebounds with the more Agility; and the Experiments that have frequently been made, sufficiently shew the vast Elasticity of the Air. There can, I think, be no Difficulty in conceiving, that there may be an Eddy of Wind from that Part of *America* which lies under the Equinoctial Line, even to us, provided there be a sufficient impelling Force, and due Resistance, and a proper Direction.

The impelling Force is a steady brisk Stream of Air, flowing perpetually from *Africa* to *America*: The Strength of this Wind may be in some measure judged of, from what Sailors observe, and express in their Language, thus: It commonly blows a good Top-sail Gale, as we sail large; and if we were to sail on a Wind, our lower Sails would be enough. I am sensible of what every Map shews us now, that the Trade-wind does not blow exactly from East to West: But though the Arrows are placed as if shot obliquely towards the Equinoctial, or rather towards a Line parallel to it, and distant from it between 4 and 12 Degrees North Latitude, yet they are all pointed Westward; and that, I presume, will be as much to the Purpose I am upon, as if the whole Stream went due West.

In order to guess at the Momentum of this repelling Force, we should consider the Breadth and
Height

Height of that Part of the Trade-wind, which I suppose to be turned this Way.

With regard to the Breadth, I read in *Dampier*, that they meet the Trade-wind at about 30 Degrees on this Side the Line; as many Degrees on the other Side will make the Whole extend to 60 Degrees broad. Methinks I do not want such a Breadth, nor indeed can I fairly expect it. For so much of this Wind as blows to the South of the most Eastern Point of *South America*, which, I think, is called *Cape St. Augustin*, should turn off Southward; the rest, which blows to the North of that *Cape*, I may lay Claim to. This *Cape* is in about 8 Degrees South Latitude, so that I may demand a Breadth of 38 Degrees; but I will make an Abatement: For though the Trade-wind, to the North of the Line, be sometimes 30 Degrees broad, yet sometimes it is not above 24 Degrees; which Variation depends, as I suppose, on the Sun's Place in the *Zodiac*: So that it is narrowest in the Winter, and widest in the Summer. Taking it then at the narrowest, when the Sun is in the Winter Solstice, we shall have a Breadth of 32 Degrees: But I allow 2 Degrees, to make Amends for the slack Wind, to the North of the Tropic of *Cancer*, and for the Calms near the Equator; and insist on 30 Degrees only, for the Breadth of that Trade-wind, which is to be reflected back to us.

How high soever that Column of Air be, which is carried through this wide Space, no more of it can affect us, than what is repelled by the Hills it strikes against, and by the cold Air which hangs over them.

I take these high Lands, and their incumbent Air, to be a Resistance sufficient to repel the Trade-wind:

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The Land must needs be so to its Height; and the Air over it, being many Degrees colder than the Trade-wind, will make a Resistance in proportion to its superior Weight. How high this Resistance may be, I cannot pretend to determine: If I require no more than 3 Miles from the Surface of the Sea to the Top of the highest Ridge of Hills, within the Tract I am now speaking of, and to the cold Air above them, I think I make but a modest Demand. Here, then, we have a Gale of Wind of the Breadth of 30 Degrees, 3 Miles high, carried with a great Velocity from *Africa* to *America*, a Momentum more than sufficient to drive the Air from *America* to us, if there be but a proper Direction.

Were the whole Stream of the Trade-wind like a Mathematical Line, mere Length, without Breadth, and were this strait Line to strike on a smooth Surface of a given Inclination, we could know its Direction exactly. For it is a Rule in Geometry, that the Angle of Reflexion is equal to the Angle of Incidence. Suppose, for Example, that the Line of Trade-wind blew just South-east, as it is said to do, South of the Equator; that the Surface it struck against ran exactly from South to North, as the Hills of *Peru* do; and that the Point of Incidence were under the Equator; in this Case the Angle of Incidence will be half a Right Angle, or an Angle of 45 Degrees, and consequently the Angle of Reflexion will be 45 Degrees: Now, as these Degrees, when the reflected Line shall have run 90 Degrees in Length, will be equal to Degrees of a great Circle, and as we are about 90 Degrees East of this supposed Place of Contact, therefore this reflected Line will,
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in our Longitude, reach to 45 Degrees of North Latitude, which is about *Bordeaux*. If we should suppose the whole Breadth of the Trade-wind to consist of an infinite Number of parallel Lines, falling on a Surface of the same Inclination, then the reflected Lines will be all parallel, and consequently the Angles will be all equal ; but they will reach wider, according to the Distance of one Point of Contact from the other ; so that if that Line, which fell on the supposed Surface under the Equator, be reflected to 45 Degrees North Latitude, that which fell on the same Surface to the North of the Equator, suppose in 23 Degrees Latitude, will reach to 68 Degrees North Latitude, which is to the Northward of the *Orcades*, and almost to the North Cape of *Norway*. Or if we suppose the Trade-wind to the North of the Equator, to flow directly North-east, as it is also said to do, and to strike against a Surface inclining from South-east to North-west, which is pretty near the Bearing of the *Isthmus* that joins *North* and *South America* ; in both these Cases the Reflexion will be towards the North-east.

But there is no depending on this way of calculating : Not that God does not act according to the exactest Rules of Geometry, in the Motion of the Winds, as well as in all other Parts of the Creation : But we do not know, at least I am far from pretending to know, all the infinite Variety of Reverberations that the Wind must have, from the uneven Surfaces it strikes against, between Cape *St. Augustin* and the Bottom of the Gulph of *Mexico*. I make no doubt but that different Parts of this Air are reflected a Thousand different Ways ; and yet that the

Whole afterwards unite; or the far greater Part, and flow this Way. I find myself under a Necessity of supposing what I cannot demonstrate Mathematically, since I can assign no other Cause why the South-west Wind blows so long with us.

But there are some other Facts which strongly support my Hypothesis; *viz.* Currents of the Sea, and the Wind in the *Atlantic* Ocean, to the Northward of the Trade-wind.

With regard to the Currents, *Dampier* tells us, it is generally observed by Seamen, that, in all Places where the Trade-wind blows, the Current moves the same Way with the Wind; and that though it be perceived most near the Shore, yet it makes no sensible Rising in the Water, as the Tides do. He says, there is always a strong Current setting from Cape *St. Augustin* Westward, occasioned, as he remarks, by the South-east Trade-wind driving the Surface slanting on the Coast of *Brazil*; which, being there stopped by the Land, bends its Course Northerly, towards Cape *St. Augustin*; and, after it has doubled that Promontory, it falls away towards the *West-Indies*, down along the Coast Westward, till it comes to Cape *Gratia de Dios*; from thence North-west towards Cape *Catoch* in *Jucatan*, thence to the Northward between *Jucatan* and *Cuba*. He says, that in the Chanel, between *Jucatan* and *Cuba*, he has found the Currents extraordinary strong; that it is probable, that the Current which sets to Leeward, on all the Coast from Cape *St. Augustin* to Cape *Catoch*, never enters the Bay of *Mexico*, but bends still to the Northward, till it is checked by the *Florida* Shore; and then wheels about to the East,
till

till it comes near the Gulph's Mouth, and passes with great Strength through the Gulph of *Florida*, which is the most remarkable Gulph in the World for its Currents, because it always sets very strong to the North.

Thus far this Pilot: And, if too great a Fondness for my own Conjecture does not prejudice me very much, I may venture to say, that these Observations strongly confirm it. He takes notice of the first Current which the Trade-wind makes near the Shore at Cape *St. Augustin*, where it is strong; thence he traces it from one Cape to another, as it winds about by different Directions, yet still gathering Strength at every Turning: It is extraordinary strong between *Jucatan* and *Cuba*, but strongest at the End of its Course in the Gulph of *Florida*. This Acquisition of Strength upon a new Direction, is contrary to the Laws of Motion; therefore it must be owing to a fresh Supply, which the rest of the Current, caused by the Trade-wind, gives it, till at length the whole Power, joined together, rushes out into the *Atlantic* Ocean.

Let us then suppose the Wind, which drives this Water before it, to follow it much in the same Course; and that, instead of striking against one plain Surface, with such an Inclination as would direct it to us, it strikes against a Million, yet still bending this Way: Let this natural Supposition be admitted, and we have the very Thing sought for, *viz.* a proper Direction.

The other Fact is this: That when our Ships return from the *West-Indies* through the Gulph of *Florida*, and are got into the wide Ocean, they have a regular

Wind at South-west, or near that Point, which sometimes attends them to their very Port. This Wind cannot have its Rise in that Ocean, nor can it come from any Continent that lies to the North, or even West of it; therefore I conclude, that it must be an Eddy of the Trade-wind.

But to all this it may be objected, that the Sea-current sets out of the Gulph of *Florida* towards the North; whereas, I say, the Wind comes towards the North-east. Sailors, it seems, take no farther Notice of these Currents, than while they are near Headlands, where they are strongest, and affect their Navigation most. But there seems to me to be a Necessity of the Continuance of this Current much farther than the Gulph of *Florida*, and of its taking new Directions from the North towards the North-east, and thence even towards the South, before it be quite spent. For it must be a vast Quantity of Water that is driven by the whole Breadth of the Trade-wind, from *Africa* to the Shores of *America*; the far greater Part of which, as *Dampier* supposes, doth flow by the Promontory of Cape *St. Augustin* Westward. This great Flux of Water has found a Passage out towards the North, between *Florida* and *Cuba*; which is the Reason, that, notwithstanding the Current sets Westward, the Sea in the *West-Indies* never rises. Here we see, that the Middle Ocean is at a great and constant Expence of Water; it must therefore want a Supply, and no Supply so natural, as for it to have its own Water again; which, after it hath passed the Gulph of *Florida*, meets with one Check still after another, till it returns to the Place from whence it came.

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For the same Reason we may suppose, that though the Eddy of the Trade wind should be reflected due North, from the Land it first strikes against; or even though it should undergo as many Turnings as the Surface of the Sea it drives before it; yet it may take a new Direction in the Ocean, caused by the Winds that blow from the Continent of *North America*.

Another Objection may be made against the South-west Wind being an Eddy of the Trade-wind, from what I myself have advanced, *viz.* that Cold is the Cause of Wind: That the *Atlantic* Ocean is too warm to produce this Wind; and yet that it comes from the Trade-wind, which blows between the Tropics, a Place much warmer: So that, according to this, here is a very warm Wind making its Way against the Cold of the North.

That Wind will blow from a warmer to a colder Quarter, is confirmed not only from the South-west raging with us in Winter, which must be confessed to come from a much warmer Climate, whatever Cause it be owing to; but from the almost daily Observation of those who live in the Country, and will look a little about them. Whoever is within the Sight of Hills, and there are few Places where there are not some in View, will find, if he takes the least Notice, that it rains in the Hills before it rains in the Vales: What can be the Cause of this Rain? Nothing, doubtless, but a Wind blowing from the Vales towards the Hills; that is, from a warmer to a colder Region, where the Vapour, which is brought thither, falls. Suppose the Air over the Hills be cold in 20 Degrees, and the Air over the Vales but in 10 Degrees, 10 cannot outweigh 20;
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but, if it gets an additional Force of 30, it will then be double the Strength of 20; and, consequently, blow from a warmer to a colder Quarter.

The *Momentum* of every Thing that moves, is made up of Two Powers, Weight and Velocity, multiplied by one another. This is fully shewn in the Butcher's Stiliard, which, with a Weight of 5 Pound, will weigh 100 Pound, by placing the 5 Pound Weight 20 times farther from the Centre, than the Thing to be weighed is placed: For 5 Pound the Weight multiplied by 20, the Velocity is equal to 100 Pound. Supposing then that the Cold to the North-east of us be 100, and the Cold which drives the Trade-wind, only 5; that is, that the Cold of the one Place be 20 times greater than the Cold of the other: But supposing the Air 5 Degrees cold, to move 20 times faster than that which is 100 Degrees; upon this Supposition the *Momentum* will be equal: And since they move in direct Opposition to one another, they will meet exactly half way, which I take to be sometimes near the Case. But if the Northern Power should lose one Half of its Weight, *i. e.* be milder, by one Half, one Winter than it is another, the other Power still continuing the same, then the South-west will blow one Half farther.

I am aware of but one Objection more, which is, that in the Gulph of *Florida*, through which I suppose the Trade-wind to flow towards us, there are variable Winds, which must interrupt this Stream, if there be any; since the same Air cannot flow different Ways at the same time.

It is no new thing to have variable Winds near the Land, even in the midst of the Way of the Trade-wind.

wind. The Westerly Winds, which, as *Dampier* says, blow on the Coast, between Cape *Gratia de Dios*, and Cape *La Vela*, are a Proof of it. The common Trade-wind on this Coast is between North-east and East; but from *October* till *March*, and chiefly in *December* and *January*, the Winds blow West; and yet when they are longest and strongest on the Coast, the Easterly Trade-wind blows off at Sea, as at other times. Near Cape *La Vela*, the true Trade blows within 8 or 10 Leagues off the Shore, when the Westerly Winds blow on the Coast. This shews that these Land-winds reach but a little Way, and therefore can have but a small, if any, Influence on the main Stream of the Trade-wind.

In smaller Navigations here in *Europe*, they find the Wind out at Sea different from what it is near the Shore, and especially near Head-lands, where it generally blows hardest, and which helped to make the Navigation of the Antients, in the *Mediterranean*, so tedious and dangerous. These variable Coast-winds may be owing to great Snows, or Rains that fall upon Highlands, when there is none, or little, at Sea, or to some Storms of Thunder that burst over them, or to their natural Coldness, or even to the Repercussion of the Air. I take the variable Winds they meet on the Coast of *Florida*, to be owing to the like Causes, which have their Influence but a little Way.

But it may be said, that these variable Winds on the Coast of *Florida* are found so near the Trade-wind, that there is no Room between them for the Eddy of the Trade-wind, I am speaking of, to pass out. It may be Fact, for aught I know: I will suppose

pose it to be Fact. But I desire the Objector to consider, that, when he is sailing, he is on the Top of the Water, and at the Bottom of the Air; he perceives the Current of Water run very fast at Top, but does not know how it runs at the Bottom. It is very certain, that there are Under-currents in Water: In Rivers that ebb and flow, it is perceived every Tide; for the Current will run up after it hath begun to ebb. By Experiments that have been made, it appears, that in some Places, where the Current on the Surface is very strong, the Under-current, running quite the contrary Way, shall be much stronger, and carry away a Boat against the Force of the upper Current.

And why may there not be contrary Currents in the Air? An Element much more subtile than Water, and therefore capable of being put into a greater Variety of Motions. The Sailor concerns himself no farther with the Wind, than as it fills his Sails, the Height of which can bear but a small Proportion with that Column of Air I am now speaking of. The Land-breezes about Islands, in the Torrid Zone, shew different Currents in the Air. For, in the Night, the Wind shall blow from the Centre of the Island, every Way, into the Sea, and even in direct Opposition to the Trade-wind, and yet give no Interruption to the Progress of it, except just in that little Spot, and for a small Height too; which is evident from hence, because in sailing to the Westward of *Barbadoes*, suppose, or *Jamaica*, without the Reach of the Land-breeze, you feel no Interruption in the Strength of the Trade-wind, by Night as well as by Day.

I, who am one of no great Observation, have frequently seen different Currents in the Air, at the same Time, and in the same Quarter, under one another. For Example: When the under Current has been East, the upper Current has been South-west, and the middle South-east. I shall appear ridiculous, if I say I see the Wind; the Vulgar think, that Swine only are endowed with that Quickness of Sight. I do not say, that I can see the Wind; but I have often seen Clouds, Weather-cocks, Smoke, and such-like Things, that are either carried or turned by the Wind. Smoke and Vanes are so near, that they can hardly cause any Deception; some Clouds may, unless properly observed: For when there are Two Tires of Clouds, both carried the same Way, and with the same Velocity, the upper Tire shall appear to move directly contrary to the lower; which Deception is owing to the different Angles that Objects of the same Magnitude, at different Distances, make on the *Retina*.

The way to observe the Motion of the Clouds, is by looking at them and a fixed Object at the same time, as the Sun and Stars, sometimes: The best superior fixed Object is the Moon in her Quarters, which may be then seen by Day-light, without offending the Eye. The fixed Objects below the Clouds are, a Ridge of Hills, lofty Buildings, or, for want of them, a Tree. By observing a Cloud with any fixed Object, you will not only see on what Point of the Compass the Clouds pass; but you will see also the Motion of the upper and under Current: By this means you will find, as the Case happens, either both Currents going the same Way, though with different

apparent Velocity; or the upper Current going one Way, and the lower another, and perhaps you will see the Smoke going a Third. This sufficiently shews, that there are different Currents in the Air.

From all my little Observation I find, that the upper Current generally prevails. For though the under Currents from, suppose, the East, or even North-east, be brisk at first, and the brisker they are at first, the longer they continue; yet they die away by degrees, as their Strength spends itself; the Air becomes near calm, and then the South-west, which before blowed aloft, descends to the Earth, and commands the whole Sky.

That the Disorders of the lower Air do not affect the Stream above, appears also from the Trade-wind passing over the very Continent, from the Eastern to the Western Side of *America*. I make no doubt but the high Hills of *Peru* cause a greater Variety of Winds and Weather, than we have here. Their Western Sea shews, that the lower Part of the Trade-wind meets with great Obstructions in passing over the Continent. For, as *Dampier* observes, you do not meet with the true Trade-wind, till you are got 150 or 200 Leagues from Shore; and then it blows in its usual manner. If all the Disturbance that the high Hills of *Peru*, said to be the highest in the World, give to the Trade-wind blowing over them, cannot intercept the upper Stream, which, after surmounting all those Heights, and the Disorder that their Cold occasions, stoops down again, till it comes to touch once more the Surface of the Ocean; we may easily suppose, that that Part of the Trade-wind, which is reflected from these Hills towards the North-east,

east, may disengage themselves, in like manner, from all inferior Obstructions, and fly over all the little low Disorders of the *Floridan* Coast.

Upon the Whole, then, though I cannot pretend to find out the Angle of Incidence, yet I must conclude, that the Trade-wind is reflected in such a manner as to cause our South-west Wind.

And I conceive, that this new Direction is so far from checking its Current, that it the rather increases it. For a great Part of the cold Air, that hangs over the Continent it strikes against, having no other Vent, flies off with the Eddy, and thereby makes more than Amends for the Stop it gave.

From *America* to the West of *England* this Wind glides over the Ocean, a plain Field, that gives no Opposition, and which, with its natural Warmth, encourages the Waft, by making the Air over it more ready to yield to the impelled Force.

Having thus opened a Passage for the Trade-wind to flow even to us, with a back Stream, if my Conjecture hath opened it ; what I have said may serve as a Hint to those who have better Materials, and can make a better Use of them : But, admitting that my Conjecture is right, we have the Cause why the South-west Wind blows with us ; and then there can be no great Difficulty in finding out the Reason why it brings so much Rain.

For this Wind blowing over a warm Ocean, which sends up many Vapours, by the time it reaches us, comes charged with an infinite Swarm of watery Bladders, which the Cold of this Climate condenses, and then down they fall in Showers of Rain.

From hence it appears, that the Two great Rulers of the Weather with us are the North-east and South-west Winds. Like Two neighbouring potent Monarchs, they are engaged in eternal Wars: Sometimes the one pushes his Conquest with great Rapidity; and sometimes the vanquished Power not only recovers its lost Dominions, but carries on the War into his Enemy's Territories with great Success. As we happen to lie near their Frontiers, we feel, by turns, the different Effects of their fierce Contention: Some Years we have a Run of North-east Winds, frosty Winters, and dry Summers; and some Years the Reverse of all this.

But if I have hit upon the true Causes of these Winds, yet the Question will be, On which Side lies the Redundancy, or Failure, that makes all this irregular Variation? For, between Two Antagonists, the Advantage will be the same to the Conqueror, whether his Superiority be owing to his own Strength, or the Weakness of his Adversary. I would be glad to find this out, but I doubt that all my little Search will not be able to do it. I will proceed as far as I can.

Let us suppose, in the first Place, the North to be intirely passive, and that all the Variation of Cold and Heat is owing wholly to a Defect, or Excess, in the South-west Wind: So that, when the South-west blows, it shall be always warm; and, when it ceases to blow, it shall be ever cold. If this be Fact, then it will follow, that whilst the South-west blows with the same steady Gale, the Weather shall be of the same Degree of Heat: But we find it otherwise; for the Nights, in a mild Winter, are colder than the Days,

Days, the same South-west still blowing ; therefore Cold, with us, is not wholly owing to a Slackness of the South-west Winds.

Let us now suppose the Privation of the Sun's Heat to be the only Cause of Cold: The Consequence will be, that all Places equally distant from the Sun, will be equally cold. But it is well known, that, in the same Northern Latitude in *Europe*, Cold is greater on the Continent than in Islands: Therefore Privation of the Sun's Heat is not the only Cause of Cold. The Sun's Absence, like other negative Causes, can amount only to the Removal of an Obstruction which hindered the efficient Cause of Cold, whatever it be, from acting.

Since the larger the Tract of Earth, the greater the Cold, the efficient Cause of Cold seems to be in the Earth; and yet, when we descend a little Way under-ground, not only in Mines, but in some Cellars, we find an even Temperament: We must therefore confine this efficient Cause of Cold to the Earth's Surface.

But if the Earth's Surface be the sole efficient Cause of Cold, since the Surface of the Earth still continues the same, the Cold should be the same on that Surface every Winter; whereas we find it otherwise. We must, therefore, seek for some concurrent Cause, between whom and the Earth's Surface this Cold is generated; and that, I think, can be no other than what is carried on the Wings of the Wind.

Dampier observes, that, after a *Tornado* at Land in *Jamaica*, the Land-wind will begin by Four or Three o'Clock in the Afternoon. The Materials of
this

this *Tornado* must be carried thither by the Wind; where the *Tornado* bursts, it cools the Air; which makes the Land-breeze begin some Hours sooner than its usual Course.

That the South-west Wind, warm as it is, carries with it the Seeds of Cold, is evident from those violent Storms of Thunder, attended with great Rains, and large Hailstones, several of which happened this last Summer.

The 8th of last *September* was a cold Winter's Day at the Place where I dwell. In the Morning, when I awoke, I perceived a great Dew on the Inside of the Glass of my Chamber-window: When I went out, I observed the Wind to be North-east, strong, black Clouds, and little Rain early, rest dry. 9th in the Morning, the Wind was North-east, brisk, dry. I began to think, that the Winter was going to set in very severe; but I was in a little time undeceived. The Afternoon of the 9th was overcast. On the 10th, I saw Colts-tails, as the Sailors call them: I take them to be *Virgil's Tenuia lanæ vellera*: Marks of Rain, that seldom deceive those who are used to observe them. On the 11th, the Wind returned again to its old Point of South-west, with Rain. Some time after, I did read in the News-papers, that on the 7th a violent Storm fell about *Worcester*, which is distant from hence about 2 Degrees, and bears, nearly, on the North-east Point. Then I found out the Cause of that little Winter.

I could mention more Facts of this Kind, but these, I believe, are enow to satisfy us, that the Seeds of Cold are carried on the Wings of the Wind. It will be needless to take notice, that the Wind carries the
Cold

Cold back again: Every one who feels his Hands tingle in a frosty Morning, and looks at the Weather-cock, must be sensible of it.

Since, therefore, a large Surface of Earth to the North of us, assisted only with a Privation of the Sun's Heat, cannot produce Cold to so great a Degree, as to affect the Weather with us; and since it appears, that that which is to help these Two Causes to produce such a Cold, is brought by the Winds, and carried off again; I must conclude, that there are frigorific Particles floating in the Air, whether they be Nitre, or by whatever Name the Chymists will call them; that they are always acting, unless obstructed by other Causes; and that, when they find a proper Recipient, and all Obstructions be removed, they act with Vigour.

When I speak of the Seeds of Cold, I do not mean, that Cold acts as a Vegetative: Though whoever considers the Order that Frost observes in building its Ice upon the Water, will be apt to think, that if it be not the Effect of Vegetation, it is something that resembles it very near.

It first shoots out a small strait Twig; then, from the same Centre, one on each Side; from these main Beams dart out smaller Sprigs on each Side, to form the Contignation; then these Rafters sending forth their Sprays, the whole Floor is laid, weak at first; but as they gather Strength, they make a Plancher, strong enough, sometimes, to bear the Weight of whole Armies passing over the *Baltic*.

I do not expect, that the Ladies will expose themselves so much to the Cold, as to see all this: But if they please to give themselves only the Trouble to
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look on their Chamber-windows in a frosty Morning, if they rise soon enough, and they will see there such Embroidery made by Ice, as their own Fingers, were they used to work, and the finest Needles, could not equal.

All this, I say, would tempt one to imagine, that there is something vegetative in what I call the Seeds of Frost. But that is not what I am about at present. All I contend for now is, that that which co-operates with the Earth's Surface, to produce Cold, which way soever it produces it, is carried to and fro by the Air.

Instead of their acting like Seeds, let us suppose them to act like inanimate Bodies: That each Particle acts with a determined Force; and that, consequently, the more of them act together, the greater their Effect. Upon this Supposition we can easily account for the different Temperament of the Air in the same Seasons. For a Continuance of North-east Winds for some Years will carry off many of these Seeds, or Grains of Cold; and an equal Continuance of South-west Winds will bring them back again; and these Periods will be longer or shorter, according to the Strength or Weakness of the Blast.

And thus, at length, I have satisfied myself, till I can find out a better Reason, why a cold frosty Winter produces a dry Summer; and a mild Winter a wet Summer. For these Seeds of Cold being the chief Cause of Frost, and their Strength being in Proportion to their Number, when the Winter is severe, there is so vast a Quantity of these frigorific Particles in *North-Europe*, that their Strength will not soon be exhausted; and, consequently, that the North-east
Winds

Winds will blow long, and make the Summers dry.

But, on the contrary, when the Winter is mild, there are but a few of those Particles in *North-Europe*, not enough to cool the Air there to such a Weight, as to enable it to hinder the South-west from reaching us, even in Winter; and therefore, when once the Sun's Heat comes to destroy those few, the South-west, which is always acting with equal Force, prevails, and brings Rain in Summer.

I make no doubt, but that a Course of Observations, kept for some Years, in several Places, would reduce the Knowledge of these Vicissitudes of Wind and Weather to some Certainty.

I have taken notice only of Two Winds, the North-east and South west, as the Producers of a long Run of dry or wet Weather: But if I have hit upon the true Causes of those Winds, the smaller Variations may be easily accounted for. I shall mention a few.

Next to those Two, the North-west Wind blows longest here, and with the greatest Force, but with various Effects. Sometimes it conspires with the South-west, to blow a mere Storm, with hard Rain; and sometimes it takes part with the North east, blows dry, and freezes. We are, in a great measure, beholding to this Wind, for the little dry Weather we have in a mild Winter.

I take this Wind to proceed from the Continent of *North-America*, where the Cold must needs be very intense, that can drive the Air from thence hither, with such strong Gusts. It is well known, that Places of the same Northern Latitude are much

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colder in *America* than in *Europe*. Upon Supposition that the North-west Wind blows from *North-America*, I can, methinks, easily account for all these contrary Effects produced by the same Wind.

Though it blows from a cold to a warmer Quarter, yet it brings Rain at first, for this Reason, because the Air over the Ocean about us is warmer than that over us. When the North-west begins to blow, it must drive the Air before it; and then the Vapour that floated in warm Air will fall down with us. Even the North-east, the driest and coldest Wind we have, will bring Rain, and for many Hours, when it sets in after a South-west.

Hence also it is that the South-east and South Winds bring much Rain, and for many Hours together. I take the South-east to come from the *Alps*, and the South from the *Pyrenees*.

I shall, at present, run no farther into Particulars; my Design being only to inquire into the Causes of a long Continuance of dry or wet Weather. It would be endless to enter into all the Predictions of Weather, that may be collected from Books, and private Observations: Most of them pretend to foretel the Weather no farther than a few Days. If those Predictions and my Hypothesis be founded on Nature, they will all admit of the same, or of a consistent Explanation.

N. F. Dec. 31. 1735.